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## RELATIVE IMPORTANCE OF ROOT GRAFTS AND BARK BEETLES TO THE SPREAD OF DUTCH ELM DISEASE

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*Abstract.*—Root-graft transmission of Dutch elm disease (DED) is sometimes ignored in both research studies and city programs to control DED. Our results indicate that elms adjacent to 1-, 2-, or 3-year-old stumps have a disease rate three to five times higher than elms not adjacent to stumps. We conclude that in Detroit, which has elm plantings typical of many United States cities, root grafts were probably responsible for more than 50 percent of the DED transmission in 1973.

Treatments for controlling elm bark beetles, vectors of Dutch elm disease (DED), commonly are evaluated by the changes in the annual disease rate after treatment. This criterion has been used despite the fact that the disease fungus is known to be transmitted through root grafts as well as by beetle vectors. A treatment for controlling beetle vectors will have little direct effect on the number of elms that become infected through root grafts. Therefore, where root-graft transmission of the fungus is extensive, a measurement of beetle control based on the changes in disease rate may have little or no significance. In view of this, we conducted studies in Detroit, Michigan, to: (1) distinguish between root-graft and beetle-transmitted cases of Dutch elm disease, and (2) determine the relative importance of both kinds of disease transmission.

## Methods and Materials

Three plots (A, B, and C) were established in 1973 about 400 m apart in a residential district of Detroit, Michigan. Most elms in the plots were 50 to 65 cm dbh, 11 to 18 m tall, and spaced about 12 m apart both along and across streets (except for gaps due to removals). The plots differed in area, number of elms, and average DED rate from previous years. Plot A was 1,200 X 1,200 m, and plots B and C were 600 X 1,200 m each.

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There were 1,469 elms in plot A, 607 in B, and 850 in C. Each year since 1970, city crews have removed about 8 percent of the residual elms in plot A, 6 percent in B, and 4 percent in C. City crews carried out their regular DED control program of sanitation and spraying with methoxychlor in all plots.

We surveyed the plots to locate all elms and 1-, 2-, and 3-year-old stumps (DED elms removed in 1972, 1971, and 1970). The elms were classified according to whether they were adjacent to stumps, and disease rates were calculated for each class to determine the spatial relationship between newly diseased elms and previous cases of DED. ("Adjacent to" is defined as on the same side of the street and within 12.2 meters.)

We first surveyed the plots for DED elms from June 11 to June 15 (just after full leaf expansion) and again from July 16 to July 20 (about 2 weeks after most overwintering beetles had emerged). In addition, city crews independently conducted their regular disease survey during July and August; and their data were included in this analysis.

## Results and Discussion

About 75 percent of the cases of DED that have occurred in the plots since 1970 are within 20 m of other cases of DED, resulting in clusters of diseased elms and stumps along city streets. This clustering may be due to beetles feeding intensively near their emergence sites in diseased elms (*Collins 1938, Wolfenbarger and Jones 1943, Zentmyer et al. 1944*). However, because most diseased elms in Detroit are removed before beetles emerge, the clustering is unlikely to be caused primarily by beetle inoculations. Further, if new cases of DED resulted primarily from beetle inoculations, elms on both sides of the street should be exposed with near-equal frequency because elm crowns overlap across the street as well as along it. Conversely, if new cases resulted primarily from root-graft transmission, new disease should occur more often in elms adjacent to previous DED because root grafts are less likely to occur in the relatively dry and compacted soil under streets.

We found that the incidence of new disease was higher for elms adjacent to stumps than for those across the street from stumps. For example, there were 97 diseased elms in plot A within 20 meters of previous DED. Only 12 of these trees were across the street, but not adjacent to previous DED. Of the other 85 diseased elms, 56 were adjacent to previous DED, and 29 were both adjacent to and across the street from these stumps. The 12 elms not adjacent to previous DED were probably inoculated by beetles. However, because the disease was primarily associated with elms on the same side of the street as previous DED, we concluded that the DED fungus was transmitted to most of the 85 adjacent elms through root grafts.

The average DED rate for all the plots for elms suspected of contracting the disease through root grafts (elms adjacent to previous cases of DED) was 22.4 percent (table 1). Although only 653 elms in the plots were adjacent to stumps, they accounted for 53.1 percent (146 out of 275) of the DED. On the other hand, the DED rate was less than 6 percent in the 2,273 elms that could have been inoculated by beetles (those elms not adjacent to stumps); these trees accounted for 46.9 percent (129 out of 275) of the disease in these plots.

Neely and Himelick (*1963*) reported that root grafts commonly occur between adjacent elms. They recommended that root grafts be destroyed with Vapam[1] to prevent disease transmission when elms are less than 10.7 m apart (*Neely and Himelick 1967*). Our data indicate that extensive root-graft transmission of the DED fungus occurred at distances of 12.2 m. Thus city foresters should consider the importance of controlling the spread of DED through root grafts at distances up to 12.2 m.

The emphasis of DED control should be on elms adjacent to stumps. In Detroit, these elms accounted for less than 25 percent of the population, but for more than 50 percent of the DED. Further, the data indicated that

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[1] Mention of a particular brand name does not imply indorsement by the USDA Forest Service.

Table 1.—Classification of elms and Dutch elm disease (DED) rates based on proximity to previous DED, Detroit, Michigan 1973

| Description of class[a] | Plot | Elms in class | Percent of total in plot | DED elms in class | Percent DED in class |
|---|---|---|---|---|---|
| | | *No.* | *Pct.* | *No.* | *Pct.* |
| All elms | A | 1,469 | 100 | 150 | 10.2 |
| | B | 607 | 100 | 55 | 9.1 |
| | C | 850 | 100 | 70 | 8.2 |
| | All | 2,926 | 100 | 275 | 9.4 |
| All elms not adjacent to previous DED[b] | A | 1,086 | 73.9 | 65 | 6.0 |
| | B | 503 | 82.9 | 32 | 6.4 |
| | C | 684 | 80.5 | 32 | 4.7 |
| | All | 2,273 | 77.7 | 129 | 5.7 |
| Elms adjacent to 1970-1972 stumps or 1973 DED elms | A | 383 | 26.1 | 85 | 22.2 |
| | B | 104 | 17.1 | 23 | 22.1 |
| | C | 166 | 19.5 | 38 | 22.8 |
| | All | 653 | 22.3 | 146 | 22.4 |
| Adjacent to 1973 DED elms | A | 172 | 11.7 | 39 | 22.7 |
| | B | 60 | 9.9 | 9 | 15.0 |
| | C | 132 | 15.5 | 27 | 20.5 |
| | All | 364 | 12.4 | 75 | 20.6 |
| Adjacent to 1972 stumps | A | 137 | 9.3 | 38 | 27.7 |
| | B | 43 | 7.1 | 12 | 27.9 |
| | C | 48 | 5.6 | 15 | 31.3 |
| | All | 228 | 7.8 | 65 | 28.5 |
| Adjacent to 1971 stumps | A | 73 | 5.0 | 16 | 21.9 |
| | B | 27 | 4.4 | 7 | 25.9 |
| | C | 17 | 2.0 | 4 | 23.5 |
| | All | 117 | 4.0 | 27 | 23.1 |
| Adjacent to 1970 stumps | A | 66 | 4.5 | 15 | 22.7 |
| | B | —[c] | — | — | — |
| | C | 26 | 3.1 | 4 | 15.4 |
| | All | 92 | 4.0 | 19 | 20.6 |

[a] Classes are not necessarily mutually exclusive because individual elms may be adjacent to more than one stump.

[b] "Adjacent to" is defined as on the same side of street and within 12.2 m.

[c] Data for 1970 stumps not available in Plot B.

an elm adjacent to a stump has a high probability of contracting disease for up to 3 years. The disease rate for these elms was over 20 percent whether the adjacent stumps were 1, 2, or 3 years old (table 1). Thus healthy elms adjacent to elms infected with DED in 1973 have about a 60 percent chance of dying by 1976.

In evaluating treatments for controlling insect vectors of DED, we should put the emphasis on changes in the DED rate only for those elms not adjacent to previous cases of DED. Disease in these elms is clear-ly due to beetle inoculations, whereas the overall DED rate may include many diseased elms not affected by beetle-control treatments.

## Acknowledgments

# Literature Cited

Collins, D. L.
   1938. FEEDING HABITS OF *Scolytus multistriatus* MARSHAM WITH REFERENCE TO DUTCH ELM DISEASE. J. Econ. Entomol. 31:196-200.

Neely, D., and E. B. Himelick.
   1963. ROOT GRAFT TRANSMISSION OF DUTCH ELM DISEASE IN MUNICIPALITIES. Plant Dis. Rep. 47:83-88.

Neely, D., and E. B. Himelick.
   1967. EFFECTIVENESS OF VAPAM IN PREVENTING ROOT GRAFT TRANSMISSION OF THE DUTCH ELM DISEASE FUNGUS. Plant Dis. Rep. 49:106-108.

Wolfenbarger, D. O., and T. H. Jones.
   1943. INTENSITY OF ATTACKS BY *Scolytus multistriatus* AT DISTANCES FROM DISPERSION AND CONVERGENCE POINTS. J. Econ. Entomol. 36:399-402.

Zentmyer, G. A., P. P. Wallace, and J. G. Horsfall.
   1944. DISTANCE AS A DOSAGE FACTOR IN THE SPREAD OF DUTCH ELM DISEASE. Phytopathology. 34:1025-1033.

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